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CHANGEABILITY AND FLEXIBILITY – AS DETERMINANTS OF RESIDENTIAL ARCHITECTURE FOR THE FUTURE

ZMIENNOŚĆ I ELASTYCZNOŚĆ – JAKO DETERMINANTY ARCHITEKTURY MIESZKANIOWEJ DLA PRZYSZŁOŚCI

A b s t r a c t

The word *change* is a synonym of today and at the same time a question about the future. In this work, the author accepts the thesis that: the changeability of housing architecture determined by flexible solutions on various levels is an attempt to prepare for an indefinite future. Based on the examples, the author explores and systematizes the subject of flexibility and variability of housing architecture. He discusses the subject at various levels, and also presents the development of the idea of flexibility, its reference to tradition, theoretical postulates and design experiments in the context of rejecting the uniformity of modernism through diversity, towards the variability and openness of architecture for the future. Based on the presented examples, the author identifies the features of residential buildings open to changes in the future. It also proves that the use of buildings, based on the technology of adaptable modular systems, in combination with participatory design, allows to combine contradictory concepts of universality and individualism in one project.

Keywords: housing architecture, flexibility, changeability, modular systems, participation

S t r e s z c z e n i e

Słowo *zmiana* jest synonimem dzisiejszych czasów i jednocześnie pytaniem o przyszłość. W niniejszej pracy autorka przyjmuje tezę że: zmienność architektury mieszkaniowej determinowana przez elastyczne rozwiązania na różnych płaszczyznach, to próba przygotowania się na nieokreśloną przyszłość. Autorka w oparciu o przykłady eksploruje i systematyzuje temat elastyczności i zmienności architektury mieszkaniowej. Porusza temat na różnych płaszczyznach, a także przestawia rozwój idei elastyczności, jej odniesienia do tradycji, postulaty teoretyczne i eksperymenty projektowe w kontekście odejścia od jednolitości modernizmu poprzez różnorodność, ku zmienności i otwartości architektury dla przyszłości. Na podstawie przedstawionych przykładów, autorka wyłania cechy budynków mieszkalnych podatnych na zmiany w przyszłości. Dowodzi również, że stosowanie budynków, opartych o technologię modyfikowalnych systemów modułowych, w połączeniu z projektowaniem partycypacyjnym, pozwala pogodzić na pozór sprzeczne koncepcje uniwersalności i indywidualizmu.

Słowa kluczowe: architektura mieszkaniowa, elastyczność, zmienność, systemy modularne, partycypacja

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1. INTRODUCTION

The well-known philosopher Heraclitus of Ephesus in the 5th century BC he declared that *The only constant thing in life is change*.[2] This philosophy is now even more valid than it was then. It refers to various levels of human life but also has its reflection in the changes taking place in the surrounding nature and the material world. Undoubtedly, this wisdom can also be applied to architecture that evolves and changes constantly, under the influence of historical, cultural, demographic, economic conditions or simply relating to the progress of civilization.

Currently, the need for changeability and flexibility has become a necessary feature of architecture. This is due to the progress, but also to the change in lifestyle and increasing individualization, which require change at various levels and influence the intensification of these processes. The word change is a reflection of today's times, but at the same time it is a question about the future. The development of the entire human civilization is based mainly on changes and experiments. We discover new directions of development thanks to crossing borders and testing new opportunities. By asking questions and challenging proven patterns, we are taking a step towards the future. Therefore, the variability of architecture determined by flexible solutions at various levels is an attempt to respond to the changes taking place in today's world. It is also a way to prepare for an unspecified future in which anything can happen.

2. OPENNESS FOR TRANSFORMATIONS – UNFINISHED ARCHITECTURE

Nowadays, we are already accustomed to changes. What is permanent and unchangeable is becoming increasingly rare, both in the sphere of architectural space and other aspects of life. The stability of human relationships, professional competences or the durability of material objects drastically decreases. In the past there were also a number of changes in the way and quality of life, but these days these processes are significantly increased, and thus more noticeable and perceptible by the whole of humanity, because they are the result of global changes. These transition no longer apply to next generations, but concern the subsequent years of our lives. As Robert Schmidt III claims, architecture has always been unfinished. It is a kind of dissonance between what most architects want the architecture to be – that is, permanent, finished, consistent work; and what architecture is in reality – namely, it is an object changing form and purpose in time and adapting to changing needs.[3] Extensions and reconstructions of single-family houses, adaptation of facilities to the needs of disabled people, or changes in the functions of unused buildins are natural. Nowadays, we observe cases where the church becomes a museum, the school becomes a nursing home and the factory is changed in a shopping center. However, making changes to an object is often very difficult, time-consuming and expensive. Despite many obstacles, changes are finally made to architectural objects. Often the only alternative is to demolish and propose

[2] The concept of change as the central element of the world is the most familiar element of Heraclitus' philosophy, which he illustrated in the famous sentence "*You can not step into the same river twice*".

[3] Schmidt III R., Austin S., *Adaptable Architecture: Theory and practice*, Routledge 2016, p. XX.

a new building presenting a new quality that correspond to the needs of the times in which it arises. Today, when we have the knowledge and experience of previous generations of architects, we should not ignore the progress and predictions about the ongoing social, demographic or economic changes. The high durability of today's construction and building materials contributes to extending the lifetime of the facility. While the proces of changes is intensified, durability should include the possibility of introducing architectural modifications on the widest possible scale.

3. CHEANGEABILITY OF THE ARCHITECTURAL SPACE IN TIME

For many decades architects conduct theoretical work and create design experiments that take into account the changeability of architectural space in time. In this aspect, we can distinguish two concepts:

- the first one – taking into account multiple short-term changes such as closing, opening, moving partitions, mobility of interior furnishings, or whole objects, etc. – which can be classified as uncomplicated, quick changes on a daily basis,
- the second one – taking into account long-term changes such as the possibility of reconstruction, extension, change in utility function, etc., based on the flexible construction and installation structure of the building – which we can classify as changes requiring more work, resources and time.

The range of architectural changeability at various levels is therefore a reflection of the fourth dimension of architecture, i.e. the time dimension, which is necessary to introduce these changes. Long-term changes are much more about the future. Short-term changes reflect the need for the present moment.[4] They usually concern the mobility of building elements, and are desirable additions to both traditionally constructed buildings and those more future-oriented, containing a flexible construction and installation structure. Desirable features of architectural changeability are therefore mainly flexible solutions that will serve not only today but also allow for future changes. While the frequency of introducing changes in residential interiors largely depends on the needs and inventions of private users, the scale of possibilities and the ease of introducing these changes depends on the internal construction of space divisions and is limited to the pre-defined usable area of a residential unit. However, in the scale of the entire building, making changes usually requires more work and time. Therefore, these changes are usually long-term. However, not the time, but the scale of difficulties in introducing potential changes is a key aspect that we should look at in more details. The need to intervene in the structural layout of the building is the main limitation of introducing changes and a factor increasing the level of their complexity and financial costs associated with the reconstruction or extension of the building. So the question arises, which construction and installation system will provide the most freedom and how to create the most flexible building structure?

[4] Magdziak M., *Flexibility and Adaptability of the Living Space to the Changing Needs of Residents*, IOP Conference Series: Materials Science and Engineering, Vol. 471, 2019.

4. BUILDING ADAPTABLE TO CHANGES

In connection with the above statement, aspects of short-term changes made in residential interiors are not considered in the following parts of this work. Further research focuses on the design process and changes made using flexible construction systems at the entire building level.

4.1. SEPARATION OF THE CONSTRUCTION SYSTEM FROM THE FLOOR PLAN

The idea of separating the structural arrangement from the building plan is rooted in modernism. After the First World War, there was a major housing deficit in Europe. Modernists were inclined to modular industrial solutions, produced on a massive scale. In 1914, Le Corbusier proposed a design Dom-ino system (Ill. 1), based on the universality of the plate-to-column structure. Developed prototypes where repetitive construction modules, finished frames, which only needed walls and windows. This system allowed free shaping and even later introduction of changes in the façade and the interiors of the building. They were independent of the construction system. Le Corbusier called this spatial flexibility as *Plan Libre*.[5] The full potential of separating the structural layout from the building plan is best illustrated by the design of Villa Baizeau from 1928 (Ill. 2). This building is not as spectacular as other Le Corbusier's projects but it best illustrates the freedom of shaping the plan and the total independence of individual floors of the building. The project was implemented in two versions. The first, more technical, is a kind of prototype, based on the simplicity of building solutions that can be adapted to the functional and aesthetic expectations of residents. The final project, second version of the house, is a development of the original idea. Changes to the internal layout of the rooms have been made here and the individually designed façades have been added in comparison with the first version.[6] The Villa Baizeau project is the prototype of many later modernist ideas regarding housing design.

An unquestionable reference to the early ideas of modernists, and the extension of the scale of the universality of the slab-to-column construction is the project of experimental homes in Kallebäck in Sweden (Ill. 3). This innovative building designed by Erik Friberger in 1960 is called Deckhouse. The building is inhabited to this day.[7] It is a prototype of flexible and prefabricated solutions of living space, which assumes the separation of the structural system from the filling structure. In this case, single-family houses are located one above the other on the subsequent floors of the building. The construction of this facility consists of three levels of reinforced concrete platforms supported by pillars and three staircases, in which electrical and sanitary installations were placed. This resulted in tripling the available area, which was divided into 18 building plots, located on both sides of the staircases. The idea was to build individual prefabricated single-family houses of various sizes and shapes, along with accompanying gardens, located on subsequent levels of the building. Thanks to the usage of prefabricated systems, the designer wanted to increase the

[5] Loos A., Le Corbusier, *Raumplan Versus Plan Libre: Adolf Loos [and] Le Corbusier*, 010 Publishers, 2008, p. 123.
[6] Gans D., *The Le Corbusier Guide*, Princeton Architectural Press, 2000, p. 144.
[7] Padovan R., *Towards Universality: Le Corbusier, Mies and De Stijl*, Routledge, 2001, p. 205.

Ill. 1. Model of Dom-ino system, arch. Le Corbusier, 1914 / source: Wimedia Creative Commons, CC Gemeentemuseum Den Haag

Ill. 2. Villa Baizeau in Cartagena, Tunisia, arch. Le Corbusier, 1928 / source: Wikidata Creative Commons

Ill. 3. Experimental residential building Deckhouse in Kallebäck in Sweden, arch. Erik Friberger, 1960 / photographer: Anette Lindgren, CC Göteborgs Stadsmuseum, source: www.kringla.nu (30.06.2019)

Ill. 4. Modular block of flats at Wohnanlage Genter Strasse in Munich, Germany, arch. Otto Steidle, 1970 / photographer: Klaus Kinold, source: www.steidle-architekten.de (30.06.2019)

flexibility and adaptability to changes in individual single-family homes. He wanted to allow an easy changes made by the residents themselves, over the years. This idea carried in itself other important aspects. Namely, the project allowed for the involvement of residents in the process of architectural creation, it gave the opportunity to express their own individuality and show diversity in the external form of the building. At the same time, the project was to provide such advantages as greater security, better control and technical quality, central heating and sanitary installations, or easier home maintenance than in the case of traditional single-family housing. However, the main advantage and idea of this experiment was to be the central location in the city combined with the comfort of living in a single-family house with a garden. Unfortunately, most of the houses have been expanded to the maximum size at the beginning of their existence, leaving no space for later expansion or garden, and above all to explore the potential of the project. This was due to the very good location of the plot, and therefore, the purchase of individual vertical plots intended for construction by wealthy people who could afford a large house. Individual houses differ in color, the arrangement of windows, but they almost completely fill the building structure. In the first impression, it looks like a compact multi-family building. The lack of a methodology and supervisory system for this experiment, ended it unexpectedly already at the beginning of construction process.

4.2. FLEXIBILITY OF THE CONSTRUCTION SYSTEM

At the same time, in 1961, the Dutch architect John N. Habraken published a book entitled *Supports: an alternative to mass housing*, which became one of the most important items presenting the idea of the flexibility of residential architecture. He presented in it the concept of *supports*, which analogically to the aforementioned project by Erik Friberger, enabled the separation of the construction system from the so-called *infill* in the building. The originality of this idea in the technical sphere extended earlier architectural ideas with the flexibility aspect of the entire structural system. It consisted of separate prefabricated elements in the form of regularly spaced columns, beams and floor panels. The originality of this idea is not only due to the technical nature of the solution but to the social aspects of the experiment. The author placed the hope in the possibility of engaging users in the design process in order to meet their needs, but also to build the identity of the place. He allowed the residents to choose the arrangement that suits their preferences, before moving into residential units. An important issue was also easy adaptation to the changing needs of the family, over the time.[8]

One of the first projects illustrating this idea was a block of flats at Wohnanlage Genter Strasse, designed by Otto Steidle in 1970 (Ill. 4). In this project, the architect was also a client. Together with Doris and Ralf Thut, he proposed a system of seven residential units, two of which were intended for a flat and an architect's studio. The building is characterized by an exposed, prefabricated, concrete skeleton frame. The intention of the architect was to create an inexpensive, flexible structure and to enable free arrangement of apartments that could meet the changing needs of residents.[9] The residential areas were connected with galleries, voids and steel staircases, which increased the diversity of the building and perfectly illustrated the

[8] Habraken N. J., Teicher J., *Supports: an alternative to mass housing*, Urban International Press, 1999.
[9] Hamm O. G., *Steidle + Partner: Wohnquartier Freischützstrasse*, Edition Axel Menges, 2003, p. 7.

idea of the system. The house built of elements was supposed to be a cheap solution allowing for flexibility and variability not only of the interior or façade but also the entire building, both during the design process and during its later usage. So it is a building for a lifetime, it does not require relocation of residents if it is necessary to increase the size of the house. It is a kind of unfinished building. The obtained form and function layout is by definition not a final one. Inhabitants entering the building also received an unfinished individual housing units for self-fulfillment.

4.3. OPEN BUILDING CONCEPT

The concept of an evolving, unfinished building also appears in an ongoing housing experiment in Japan. In the city of Osaka, in 1993, the building NEXT21 (Ill. 5) was created. The project was developed by Osaka Gas Corporation in cooperation with the NEXT21 planning team headed by architect and professor at Tokyo University – Yositica Utida. The building consists of 18 residential units. In 1994, the first residents moved into it, starting an experiment taking into account the exchange of inhabitants and adaptations of flats. The design in terms of construction is similar to Otto Steidle's project but much more advanced in terms of flexible installation layout and social integration of residents. All cables and pipes have been placed in raised floors and distributed along communication spaces, analogously to the media distributed in the city under the street network. The distribution of media is a key aspect of this project, which allows basically any arrangement of rooms and functions in the building. This is a technological step forward in comparison to previous projects, where the installations were arranged in vertical shafts. Such a stiff arrangement of the installations, allowed to create various floor plans, but introduced some limitation for the location of the kitchen or sanitary rooms. NEXT21 is an attempt to search for an architectural response to global changes taking place in urban communities, both in demographic and sociological aspects. It discusses the subject of an aging population, new configurations of families and co-inhabitants. The evolution of the project, for research purposes, has been accelerated by forced phases of long-term changes. About every five years, residential units are rebuilt to meet the needs of new inhabitants. According to the idea of sustainable architecture, the possibility of re-use of most building components in the remodeling process is assumed. The building contains green spaces, semi-public spaces to integrate residents and modern renewable energy sources. Each phase of the experiment is focused on another, currently significant problem. The current phase (2015–2020) discusses the future prospects for housing and energy.[10] NEXT21 is an example of the so-called Open Building[11] and is the most often cited example of experimental residential architecture for the future. The concept of open buildings has already become a standard for the design of office and service facilities, where the need for changes and reorganization of space appear more often than in residential buildings. Currently, the concept of open residential buildings, in varying degrees and under various names, has already spread to the majority of highly developed countries.

[10] *Future Report – Exploration Neo-futristic experimental residential complex*, Osaka Gas Corporation, https://www.osakagas.co.jp/en/company/enterprise_future/article3/ (30.06.2019)
[11] Leupen B., Heijne R., van Zwol J., *Time-based Architecture*, 010 Publishers, 2005, p. 176.

Ill. 5. Open residential building NEXT21 in Osaka, Japan, arch. Yositika UTIDA, Shu-Koh-Sha Architectural and Urban Design Studio, 1993 / source: Google street view (30.06.2019)

5. DISCUSSION

While modernism reduced the user's influence, proposing uniformity and standardization in housing, the new ideas restored the subject of universality and flexibility in a new version, referring to the social aspects of freedom of choice and decision-making in the process of shaping the surroundings by the residents themselves. In new projects, residents were allowed to participate and express their own creativity and individuality in creating their own unique apartments.

On the basis of the presented examples, the development of features of architectural changeability over the years is evident. Undoubtedly, the flexibility and the ability to modify space are pro-future features. They allow to combine seemingly contradictory concepts of a durable and changeable architectural space. Therefore, the key challenge for architecture for the future is to look for design solutions that will respond to the needs of today's users, but also allow for later adjustment of the facility to unspecified needs that will probably appear one day. This unpredictability of the future leads to searching for versatile, universal solutions, suitable for each user. This carries the danger of uniformity. However, lessons from the history of architecture and the experience of modernist architectural and urban projects show that these ideas lacked individualism, which is the basis of the identity of modern society. Taking

into account the aspect of changeability, the architect is able to give freedom of choice and engage users in the process of creating unique architectural space. Through this, a chance is created to include what is common and individual in one architectural project. It is an attempt to make contradictory concepts complementary to each other.

The presented examples impress with the innovativeness of architectural solutions. Due to the fact that they are not a finished work but a process of design changes, some doubts arise. The process of reconstruction of flats where there is a change in the size of a residential unit is doubtful. This idea can only be implemented in a housing for rent. In the case of NEXT2 this is possible because the facility belongs to Osaka Gas Corporation, and the residents are employees. In the case, where individual housing units are privately owned, this process would certainly be very difficult if not impossible. The success of this building is therefore dictated by the supervision over the entire experiment and the change process established from the upper stage. Thanks to this control, the reconstruction of apartments is also better organized and shortened to just two weeks' time. Involvement of over a dozen architects in the project ensures the desired quality of residential units. It is therefore difficult to determine whether this process would run equally smoothly without the intervention of specialists and whether it would bring the expected results. An important aspect is also accessibility for people with disabilities. The idea of diversity in this object is also manifested in a diverse communication system. Finally, the elevator was added, but according to Japanese tradition, there are differences in levels denoting different zones – both inside housing units and in communication spaces. Also in terms of aesthetics, NEXT21 evokes criticism. The exposed reinforced concrete structure and diversity of facades of individual residential units for many people is too harsh and chaotic, but from the point of view of residents and initiators of the experiment, it is a reflection of the image of changing city and the individuality of the inhabitants.

6. CONCLUSION

Design freedom and rejection of patterns in thinking about architecture and urban planning appear in criticism and architectural manifestos since the 1960s. It was postulated to reject uniformity and adopt the concept of architectural and spatial individuality. In this context, diversity as the guiding concept for the development of mass construction has become an important aspect of architectural discourse. There were numerous experimental typological and modular projects, especially in the Netherlands and Japan. The beginning of the 90s is the time of abandoning the standardization and opening of architects to the indeterminacy and changeability of the modern city. Nowadays the approach to architectural design, as an attempt to create final, ideal building concept, gives way to ideas that include the aspect of variation. The concept of unfinished buildings, the variety of modifications and ability to change are architectural features that can help adapt to the unexpected future. A new approach to design makes architects free from searching for the perfect solution. Concept of a time-evolving building, puts individuality on the pedestal.

On the basis of the presented examples, the unquestionable advantage of using modular systems emerges. They enable easier implementation of changes than in buildings with a traditional structure. Desirable characteristics of residential buildings for the future refer to both technical, economical and sociological aspects, as well as to the idea of universal design and sustainable development. These are:

- Clear, prefabricated construction system
- Free installation layout
- Reuse of building components during remodeling
- Adaptation to the family development cycle and changes of users' needs
- Accessibility for people with disabilities
- The use of modern technologies and renewable energy sources
- Increased building intensity
- Flexible size of a residential unit
- Personalization of the living space
- Diversified group of inhabitants
- Project participation
- Common spaces – integration of residents
- Introducing greenery to common spaces
- Supervision over investment and changes
- Caring for the aesthetic value of architecture

In addition to all the advantages, the use of modular systems carries the risk of focusing on technological aspects, leaving the aesthetic value of architecture in the shadow. Participation of residents in the design process also enforces control over the project in order to achieve a consistent architectural expression. The introduction of changes should be regulated and consulted with specialists and the entire community in order to avoid aesthetic chaos that could result from the unlimited design freedom. However, the success of creating residential buildings for the future is mostly conditioned by appropriate architectural education affecting the designers' awareness of future challenges, as well as the social responsibility of the society.

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